

## **Justification for Experimental Authorization Request**

### **5Nines, LLC**

#### **a) Market study of decoder support for AVC and HEVC transport streams on 8VSB/ATSC 1.0 MPEG TS:**

We know empirically from lab tests that multiple television display panel manufacturers who offer "ultra high definition" displays are capable of decoding HEVC within a MPEG-2 TS. What remains unknown is the extent to which subtle features of the AVC and HEVC codecs are broadly "implemented" by display manufacturers. In our current study of codec compatibility, we have found at least one vendor that does not properly parse supplemental enhancement information (SEI) data, transported in codec-specific network abstraction layer (NAL) data related to hypothetical reference decoder (HRD) coded picture buffer (CPB) management. Absent correct functioning and support for NAL HRD in a display decoder, a display essentially becomes unable to properly decode and display pictures in an expected and stable manner. Various decoder idiosyncrasies have been observed in our lab testing in which at least one vendors' display decoder would frequently 'hiccup' when decoding HEVC programs using VBR and VBV bitrate management features.

According to our tests, an improperly managed HRD CPB function manifests as visible frame drop during decode, and results in non-uniform frame 'judder' throughout a tuned program. In addition to failing to decode particular frames, at least one display vendor suffers from ever-increasing lip sync 'skew' as a tuned program plays. In this display, whenever frames are dropped, its HEVC decoding process would be reset and restarted, and pause its audio output. Unfortunately, discarding and restarting picture decoding functions while not discarding corresponding audio samples, results in ever-growing apparent delay in the audio program. This process continues until the displays controlling UI and other functions cease to work, presumably due to an out of memory condition or other related software/hardware pathology.

Clearly, given work to date, vendor support for HEVC without regard to its transport (i.e. OTA MPEG TS, file based, app based, etc.) is at best fragmented and largely unreliable in the aggregate. To this end, understanding and capturing viewer feedback from specifically crafted MPEG2, AVC, and HEVC payloads within an ATSC 1.0 TS will aid in our understanding and reporting of this feedback to display vendors and designers, well before COFDM/NEXTGEN tuner and display support becomes commonplace.

#### **b) Multiple transmission diversity techniques for 8VSB:**

We seek to investigate, compare, and contrast multiple transmit diversity techniques for 8VSB utilizing several approaches. These proposed techniques can be grouped into the following categories:

- i) Hybrids of simple, asynchronous (relative the symbol rate and other aspects of the 8VSB signal) Tx switching (i.e. square, sigmoid, different levels of overlap).
- ii) Same as a), but with frequency and phase synchronization related to symbol rate, VSB frame, and field time bases.
- iii) Orthogonal frequency domain filtering (i.e. structured, opposing "comb" filtering on (n) emitting antenna ports)
- iv) Combinations of a, b, and c, with gross levels of simple, whole-transmission-channel delay (i.e. sub microsecond to hundreds of microseconds) applied to one or more transmission antenna ports in a plurality of delay ratios.